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THE USE OF ANTARCTIC, MULTI-PURPOSE (MP-1) FUEL IN SPACE HEATERS, CAMP STOVES, AND LANTERNS

BY

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ABSTRACT

The specifications for a multi-purpose fuel, MP-1 (MIL-F-23188) have been developed by the Bureau of Naval Weapons. This fuel, proposed for use at Antarctica in aircraft turbines, diesel engines, and space heaters, has received prior approval for use in C-130 and C-135 aircraft. The current study was undertaken to determine its suitability for use in space heaters, emergency camp stoves, and lanterns.

The tests indicate that, as a fuel for "pot type" space heaters, MP-1 is superior to the presently used DF-A, space heater fuel.

MP-1 is not recommended as a regular fuel for pressurized camp stoves and lanterns which normally burn white gasoline. Under emergency conditions, however, MP-1 can be used in these units for short periods of time.

INTRODUCTION

In order to provide a more effective fuel support for Antarctic operations, a fuel simplification program was initiated approximately three years ago, with the goal of developing a single fuel which would be compatible with jet turbines, compression-ignition engines, and space heaters.

The result of this effort, by the Bureau of Naval Weapons, was the development of Specification MIL-F-23188 (28 February 1962), Fuel, Multi-Purpose, Antarctic; MP-1 (see Appendix A). This was to be a fuel of limited availability, designed specifically to satisfy the requirements for extreme low temperature operation in aircraft turbine engines, medium and high speed diesel engines, and space heaters. It was intended primarily for use in the Antarctic "Deep Freeze" program, and was expected to replace the currently used Arctic diesel fuel (DF-A) and JP-4 aviation turbine fuel, in these areas.

MP-1 has previously been tested and approved for use in C-130 and C-135 aircraft (see Reference 1). The current report, covering the test and evaluation of MP-1 in space heaters, emergency camp stoves, and lanterns, is provided in compliance with a portion of the provisions of Reference 2 and Reference 3.

PROCEDURES AND RESULTS

Coleman 50,000 BTU Per Hour Space Heaters

On 15 December 1964, an order was placed with commercial sources for the delivery of two Coleman Model 870C space heaters of the type having an output of 50,000 BTU per hour each. These were standard production units as produced by the Coleman Company, Inc. of 250 North St. Francis Avenue, Wichita, Kansas 67201.

The heaters were subsequently set up outdoors under a shed roof (see Figure 1) with sufficient vertical smoke pipe to produce a draft equivalent to 0.06-inches of water, as per the manufacturer's recommendations.

Standard 55-gallon drums mounted horizontally on 3-foot-high stands, and directly connected with copper tubing, provided the necessary fuel supply facilities. The manufacturer's instruction with regard to suitable fuel for these units read as follows:

"Coleman Oil Burning Heaters are Designed to Operate on Straight-Run No. 1 Fuel Oil (Commercial Standard Specification CS12-48)"

In the NCEL test, however, instead of No. 1 fuel oil, as per Specification CS12-48, one heater (Serial No. K403087) was operated on diesel fuel-Arctic (DF-A) and the other (Serial No. K403105) was operated on multi-purpose (MP-1); Appendix B shows a comparison of fuel properties.

The initial test schedule, which was conducted eight hours per day, five days per week under ambient temperature conditions starting on 15 January 1965, consisted of the following:

1. 50 hours of operation at "1/4" fire
2. 50 hours of operation at "1/2" fire
3. 50 hours of operation at "3/4" fire

The operation of both heaters up to this point was satisfactory, although there was considerable soot formation in both during the "3/4" fire run. They were then advanced to the "full" fire setting.

After approximately two hours of operation at the "full" fire position, heater Serial No. K403087 burning DF-A failed (that is, the fire extinguished itself due to an excessive soot buildup in the vaporizing chamber). One hour later, the testing of heater Serial No. K403105 burning MP-1 was also discontinued due to a similar, although not so critical, soot problem. (See Figure 2 and Figure 3)

Both heaters were then completely disassembled and thoroughly cleaned, inside and out. Upon reinstallation at the test site, an additional ten feet of smoke pipe was added to each stack, which increased the available draft from 0.06 to 0.10 inches of water.

The test continued on a schedule as follows:

4. 50 hours of operation at "3/4" fire (repeat)
5. 50 hours of operation at "full" fire

At this point, after a grand total of 250 hours of operation, both units were performing very satisfactorily.

As a final check to ascertain if there was any appreciable difference in the rate of soot formation between the two heaters, they were again cleaned, the fuels reversed (that is, DF-A was supplied to Serial No. K403105 and MP-1 was supplied to Serial No. K403087), and a final 50-hour run was made at the "3/4" fire rate. An inspection at the completion of this schedule showed that the results in either heater were consistent.

This series of tests demonstrated that MP-1 is a considerably cleaner burning fuel in Model 870C heaters, than is DF-A under the same conditions. The heater supplied with DF-A consistently developed a much thicker, oilier coat of soot in its combustion chamber and stack, than did the MP-1 unit. DF-A also formed large clinker-like deposits between the rings in the combustion area, which were not in evidence with MP-1 fuel. As may be noted in Figure 3, such soot as was formed in the burning of MP-1 was rather light and dry, and did not adhere tightly. On the other hand, DF-A soot was well attached, and was hard to remove.

In an investigation of the fuel metering characteristics of the Coleman space heaters, a check was made of fuel delivery rates. The factory specifications indicated that 33 cc per minute at "full" fire setting was to be expected. With DF-A fuel, the delivery was almost exactly 33 cc per minute. With MP-1, the metering mechanism delivered approximately 39 cc per minute. This added fuel delivery (and associated heat) is considered to be an important factor influencing the character of the soot deposits.

In order to determine the cold ignition properties of the two test fuels, separate containers of MP-1 and DF-A, each containing a small wick, were cold soaked for 24 hours at -55 degrees F. At the touch of a cigarette lighter flame, both wicks ignited at -55 degrees with no more apparent delay than at room temperatures.

Coleman Camp Stoves and Lanterns

To evaluate the possibilities of using MP-1 as fuel in small emergency cooking and lighting equipment, items were procured for testing as follows:

Quantity	Description
2	Single burner Sportster stove, Coleman Model 502-700 (see Figure 4)
2	Single mantle lantern, Coleman Model 200A (see Figure 5)
2	Two-burner camp stove, Coleman Model 425D (see Figure 6)

All of these units, it should be noted, were designed for operation on white (unleaded) gasoline. They were received in new condition, and were given an initial, short, operational check on white gasoline to make certain that all were in good working order.

The first test involved the single burner Sportster stoves. One was fueled with MP-1 and the other with white gasoline. When operated at 65 degrees F ambient temperature, both stoves performed adequately,

although the MP-1 unit required a few seconds longer to light. In order to check for any possible differences between stoves, fuels were switched, but results were again the same.

Both stoves were then cold soaked at -10 degrees F for 24 hours. Under these conditions, it was nearly impossible to light either the unit containing MP-1 or the one with white gasoline. Experimentation with various means of ignition disclosed that lighting with either fuel could be readily accomplished by the simple expedient of placing a small piece of braided asbestos in the dished top surface of the burner, directly under the generator (see Figure 4). The dish was then filled with the fuel being used (alcohol and lighter fluid were also acceptable). The asbestos wick was easily fired, and the generator allowed to preheat for approximately one minute before attempting to ignite the stove burner. Under these conditions, it was no problem to light the stove with either fuel. A repeat of this procedure at -20 degrees F was also successful. The cold chamber temperature was then lowered to -40 degrees F. At -40, it was found to be practically impossible to light either the MP-1 stove or the white gasoline stove, regardless of the procedure used. This problem was primarily due to the exposed configuration of the generator and carburetor, which prevented fuel vaporization at low temperatures.

The second test involved the two-burner camp stoves. Here again at 65 degrees F ambient temperature, normal operation on MP-1 was possible, although ignition was slightly more difficult than with white gasoline. At -10 degrees F, even with the use of the auxiliary asbestos wick, lighting with either gasoline or MP-1 was very difficult. At -20 degrees F, it became virtually impossible to light either of the two-burner stoves. This situation was the result of the longer and more exposed position of the "generator," as compared with the single burner Sportster type.

The third test included the single mantle lanterns. The lanterns, one fueled with MP-1 and the other with white gasoline, were taken through a series of cold soaking and lighting attempts identical to that applied to the stoves. At 65 degrees F ambient, the MP-1 lantern could be lighted with no appreciable difficulty. Through the use of the asbestos wick and auxiliary fuel technique, lighting on either fuel was possible down to -20 degrees F. In the case of the lantern, the configuration of the generator, carburetor, and burner is such that the preheating is more effective and, in addition, the glass shield acts to retain the heat. At -40 degrees F, however, it was impossible to light either lantern, principally due to the fact that at this temperature, heavy gloves were required by the operator. Under these conditions, burning matches could not be successfully manipulated into the small opening provided in the lantern for lighting.

At the conclusion of the low temperature tests, all stoves and lanterns were completely disassembled and inspected for the presence of deposits or other evidence of malfunctioning. At this time, all generator needles were

found to have a fairly heavy coating of hard carbon. However, inasmuch as fuels had been switched at various times between units, it was necessary to make an additional test run to pinpoint the source. The two lanterns were, therefore, thoroughly cleaned, one fueled with MP-1 and the other with white gasoline, and both lighted. (A preheating wick was not used.) The lanterns were then allowed to burn for sixteen hours under ambient temperature conditions of approximately 65 degrees F. At the conclusion of this period, the lanterns were again disassembled and closely inspected. At this time, it was noted that the lantern which had burned white gasoline was completely clean -- inside and out. The unit operated on MP-1 was found to have a considerable coating of soot on the globe, the carburetor, and the ventilator (see Figure 7). An inspection of the generator needle (see Figure 8) revealed the presence of a hard, baked-on carbon coating.

CONCLUSIONS

1. MP-1 is a most acceptable (superior) fuel for use in "pot type" space heaters of the type similar to Coleman Model 870C.

2. MP-1 is not recommended as a substitute for white gasoline in portable, pressurized, camp stoves and lanterns.

3. In case of emergency, MP-1 may be used for short periods of time in single burner camp stoves and in lanterns, at temperatures down to a minimum of -20 degrees F (in two-burner camp stoves, the temperature limitation is -10 degrees F). If MP-1 (or white gas) is used in these units at low temperatures, a means of auxiliary preheating is a necessary aid to lighting.

4. The use of MP-1 in camp stoves and lanterns, as an emergency procedure, will necessitate the frequent, thorough cleaning of all combustion components.

ACKNOWLEDGEMENT

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REFERENCES

1. Middletown Air Material Area message 202025Z of May 1964.

2. COMNAVSUPPFOR letter serial W-449 of 9 July 1964 to BUDOCKS.

3. BUDOCKS letter 42.310/FK:mvs of 5 August 1964 to NCEL.

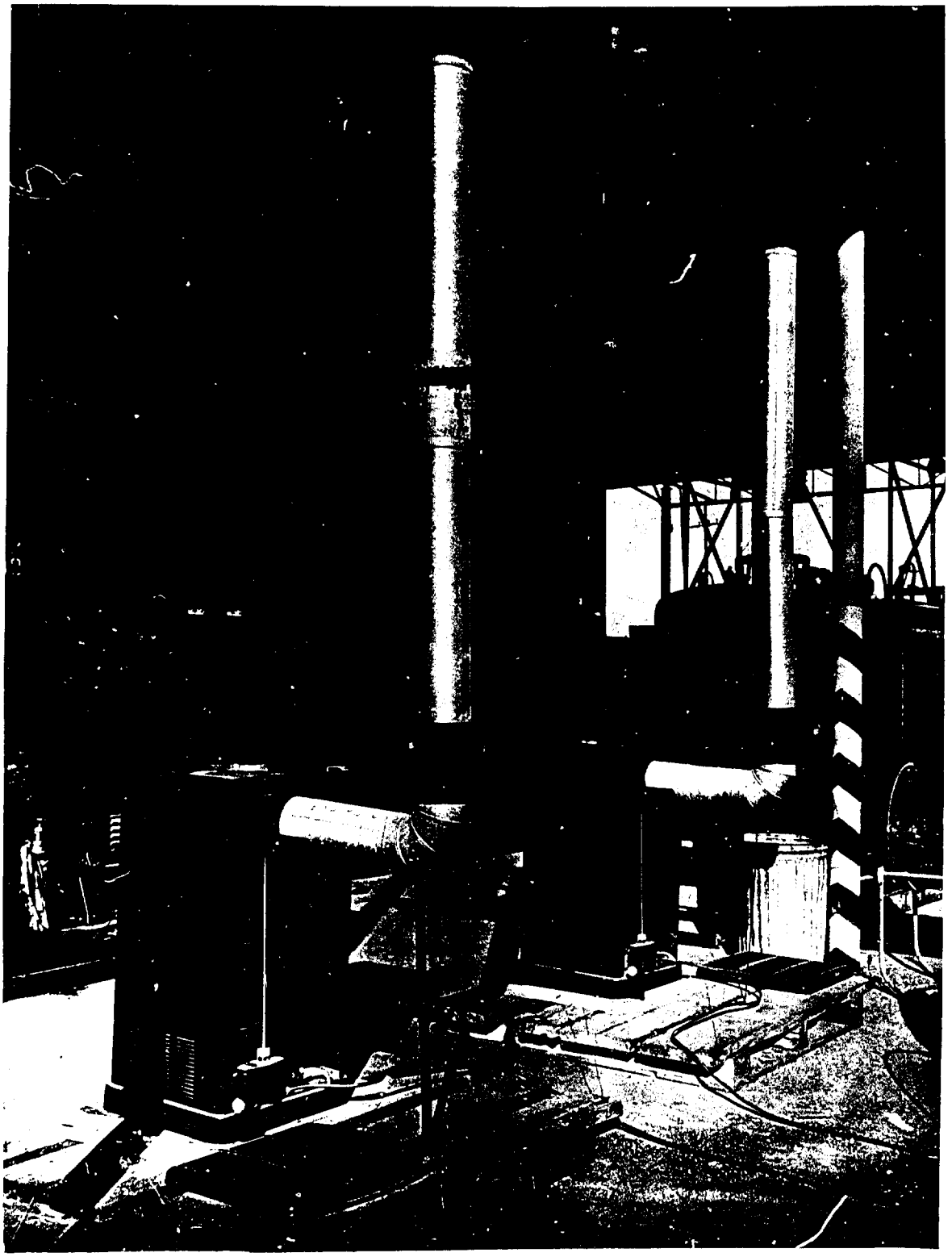

Figure 1. 50,000 Btu space heaters at test site.

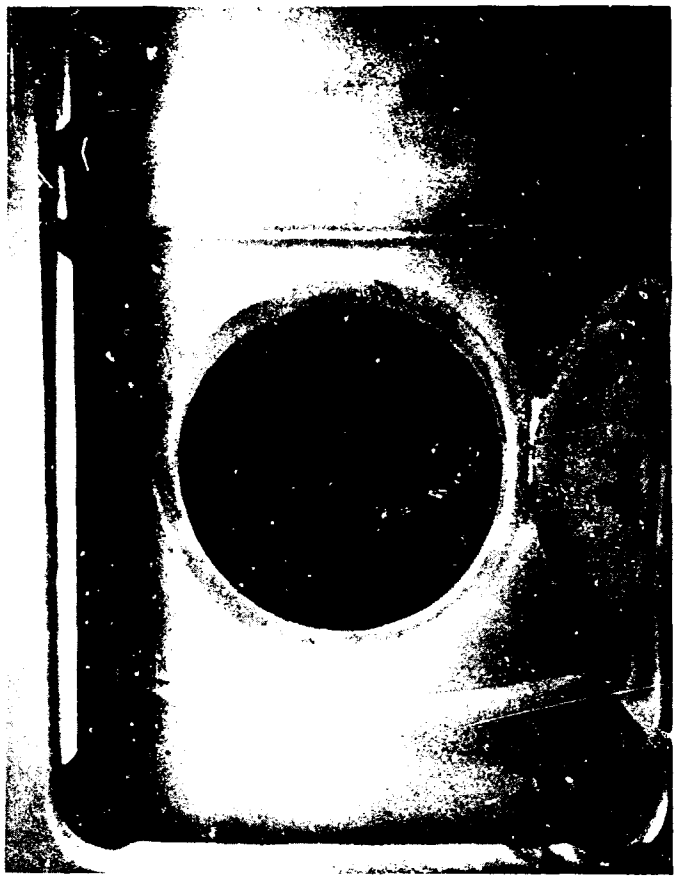

Figure 2. View inside DF-A burning heater after stoppage due to soot. Note moist, tenacious nature of soot.

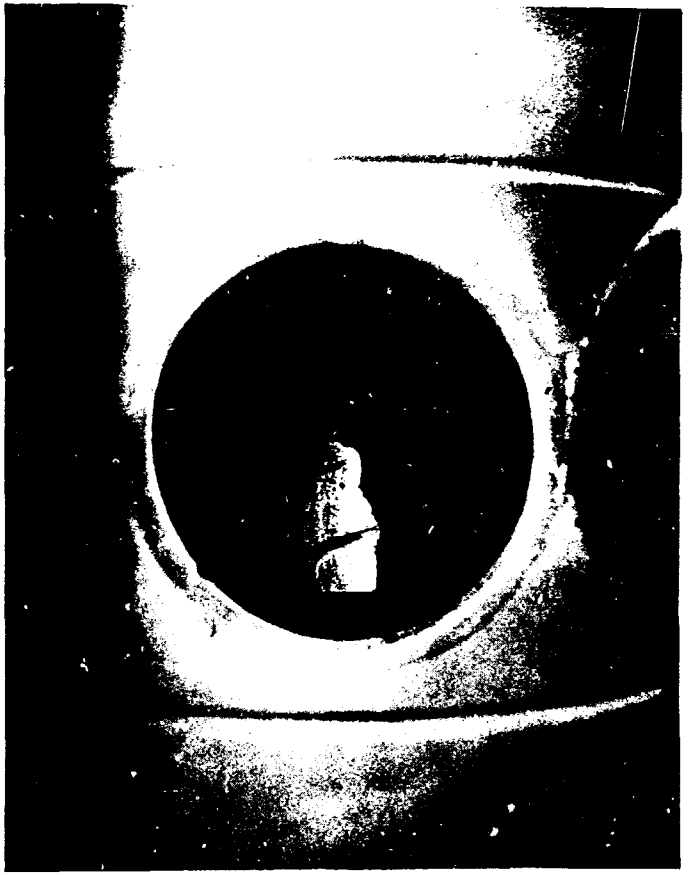

Figure 3. View inside MP-1 burning heater after stoppage due to soot. Note dry, loose nature of soot.

Figure 4. Coleman single burner Sportster Model 502-700.

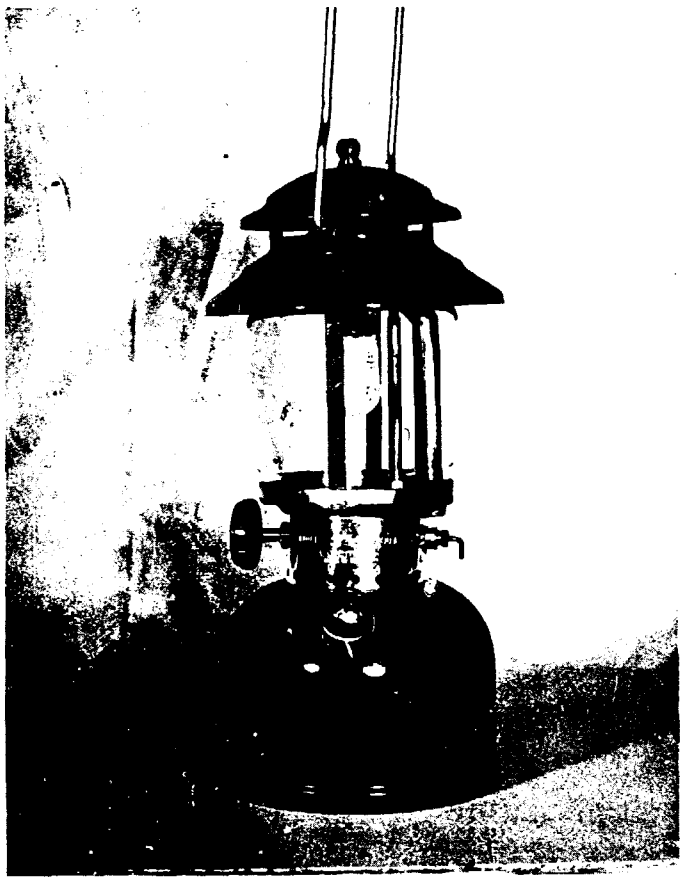

Figure 5. Coleman single mantle lantern Model 200A.

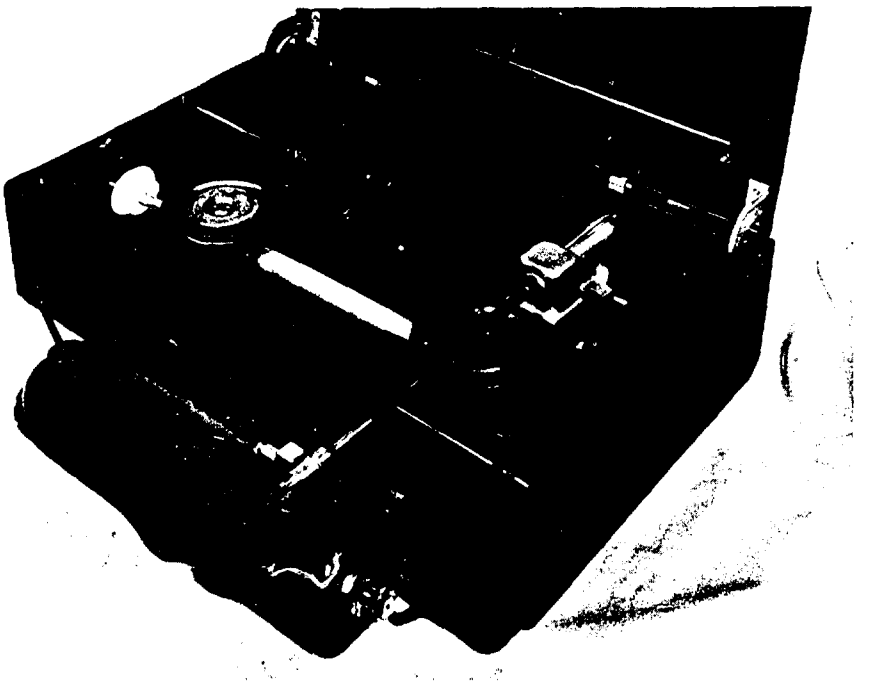

Figure 6. Coleman two-burner camp stove Model 425D.

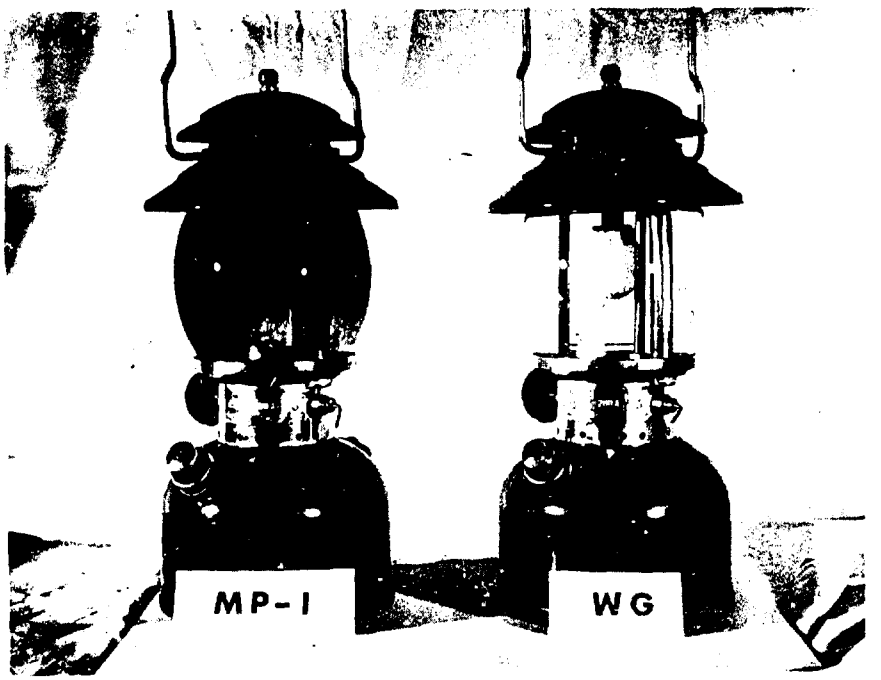

Figure 7. Results of 16-hour burning test. Note soot deposits on the lantern that had burned MP-1.

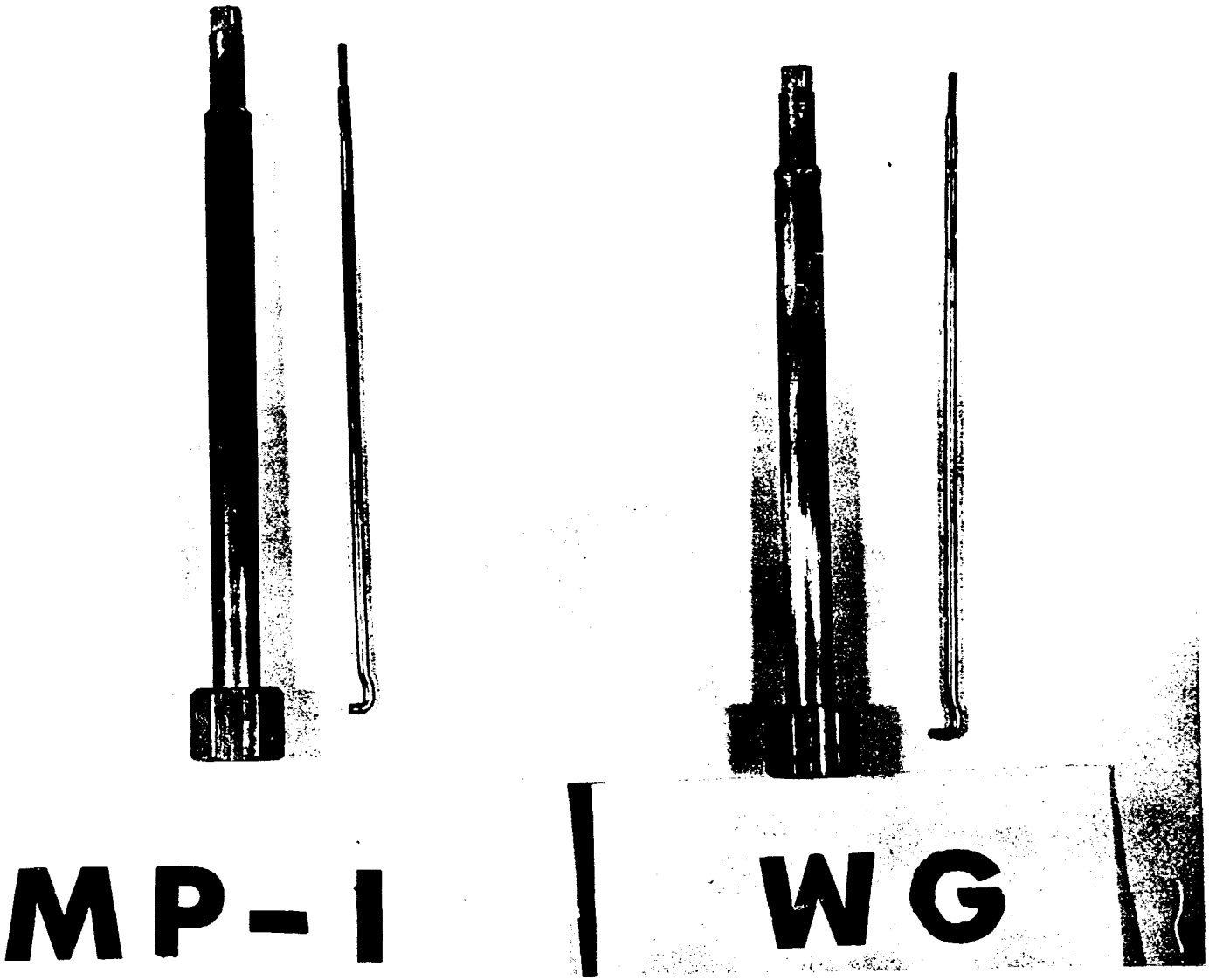

Figure 8. Generator and cleaning needle following 16-hour test. Note heavy carbon deposits on parts from the lantern that had burned MP-1.

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